MOTOR DRIVEN COMPRESSOR

Technical Field

The present invention relates to a motor driven compressor, more particularly, which can use refrigerant sucked into a swash plate chamber of the compressor to efficiently cool an electric motor.

Background Art

In a swash plate type compressor generally used as a compressor of a vehicle air conditioning system, a swash plate in the form of a disk is installed at an inclination angle in a drive shaft for selectively receiving engine power through the engagement/disengagement of an electric clutch or directly receiving power from an electric motor to be rotated by the drive shaft and a plurality of pistons installed around the swash plate with shoes interposed therebetween to linearly reciprocate within a plurality of bores formed in a cylinder block in cooperation with this rotation so that refrigerant is sucked in from an evaporator, compressed, and discharged toward a condenser.

There are various types of compressors that are generally divided into reciprocal and rotary types, in which the reciprocal compressors are divided into crank type, swash plate type and wobble plate type compressors, and the rotary compressors are divided into vane rotary and scroll type compressors. Some of the compressors are called variable capacity compressors since they can vary volume.

Further, there are motor driven compressors which are driven by electric motors as power source, and divided into scroll type and swash plate type motor driven compressors.

In the meantime, the swash plate type compressors are divided into a single head swash plate type compressor if compression is performed at one side

by pistons and a double head swash plate type compressor if compression is performed at both sides by pistons.

A motor driven compressor using an electric motor as a power source includes a motor unit having a motor and a compressor unit for compressing refrigerant. The motor unit is heated since the electric motor installed therein is rotated at high speed, and this heat generation also functions as a factor of degrading the entire performance of the motor driven compressor. Accordingly, the motor driven compressor has an important requirement to cool the motor unit.

A number of techniques have been developed already as means for cooling the motor unit of the motor driven compressor.

Japanese Patent Publication No. 1997-32729 discloses a scroll type compressor in which suction refrigerant is flown through a motor room to cool a motor before being compressed in a compressor unit. However, according to this cooling scheme, sucked refrigerant is introduced into the compressor unit via a motor unit to raise the temperature and pressure of refrigerant in a low pressure section, thereby causing problems of the performance degradation of the compressor such as compression efficiency degradation.

According to a scheme applied to the swash plate type compressor using single head pistons, sucked refrigerant is introduced to the motor unit to cool the same and then re-compressed via a low pressure section of the compressor. This scheme may be also performed based upon multiple stage cooling, by which refrigerant compressed in a first piston is introduced to a motor unit to cool the same and then re-compressed by a second piston before being discharged. This scheme is disclosed in Japanese Patent Publication No.2001-200785. However, this cooling scheme has problems in that refrigerant is introduced into the motor room through a channel isolated from a swash plate chamber failing to sufficiently lubricate the swash plate chamber and compression is performed only at one side making pressure pulsation characteristics poor compared to double head swash

plate type compressor. Furthermore, it is required to have a large inclination angle of the swash plate so that load a high speed rotation lowers durability.

Disclosure of the Invention

The present invention has been made to solve the foregoing problems and it is therefore an object of the present invention to provide a motor driven compressor which is so constituted that refrigerant is fed from a swash plate chamber partially into a suction chamber of a front housing via a motor room and partially into a suction chamber of a rear housing in order to improve the cooling efficiency of an electric motor and the entire performance of the compressor while efficiently lubricating sliding components of the swash plate chamber thereby improving durability.

According to an aspect of the invention for realizing the above objects, there is provided a motor driven compressor comprising: a motor unit having an electric motor installed in an inside motor room for rotating a drive shaft; and a compressor unit installed at one side of the motor unit, wherein the compressor unit comprises: a front housing having at least a discharge chamber therein; a rear housing having a suction chamber and a discharge chamber formed therein, the suction chamber being partitioned from the discharge chamber and a refrigerant discharge port formed at one side communicating with the discharge chamber; a cylinder block coupled between the front housing and the rear housing and having a plurality bores formed at both sides of the swash plate chamber and a refrigerant suction formed at one side thereof; a swash plate placed in the swash plate chamber and coupled with the drive shaft and a plurality of double head pistons for reciprocating within the bores in cooperation with the rotation of the swash plate; and feeding means for feeding refrigerant from the swash plate chamber partially into the motor room and partially into the suction chamber of the rear housing.

Brief Description of the Drawings

FIG. 1 is a sectional view illustrating a motor driven compressor according to a first embodiment of the invention;

FIG. 2 is a perspective view illustrating a cylinder block in FIG 1;

FIG. 3 is a sectional view taken along a line A-A in FIG. 1;

FIG. 4 is a sectional view taken along a line B-B in FIG. 1;

FIG. 5 is a sectional view illustrating a motor driven compressor according to a second embodiment of the invention;

FIG. 6 is a sectional view taken along a line C-C in FIG. 5;

FIG. 7 is a sectional view taken along a line D-D in FIG. 5;

FIG. 8 is a sectional view illustrating the motor drive compressor according to the second embodiment of the invention with an inlet passage modified in position;

FIG. 9 is a sectional view illustrating a motor driven compressor according to a third embodiment of the invention;

FIG. 10 is a sectional view taken along a line E-E in FIG. 9; and

FIG. 11 is a sectional view taken along a line F-F in FIG. 9.

Best Mode for Carrying Out the Invention

The present invention will now be described in detail in connection with preferred embodiments with reference to the accompanying drawings.

The components and operations the same as those of the prior art will not be described again.

FIG. 1 is a sectional view illustrating a motor driven compressor according to a first embodiment of the invention, FIG. 2 is a perspective view illustrating a cylinder block in FIG 1, FIG. 3 is a sectional view taken along a line A-A in FIG. 1, and FIG. 4 is a sectional view taken along a line B-B in FIG. 1.

As shown in FIGS. 1 to 4, a motor driven compressor 1 of the invention includes a motor unit 10 and a compressor unit 20 coupled with the motor unit 10 for receiving power from the motor unit 10 to compress refrigerant.

First, the motor unit 10 has a motor room 12 with a predetermined space therein and an electric motor 13 installed in the motor room 12 for rotating a drive shaft 14.

The drive shaft 14 rotatably supported at one end by a bearing 16a provided inside the motor housing 11 and at the other end by a bearing 16b, in which the other end is extended to a rear cylinder block that will be described later.

The compressor unit 20 includes a front housing 30 coupled to the motor unit 10 and having a discharge chamber 31 therein, a rear housing 60 and a cylinder block 40 coupled between the front and rear housings 30 and 60, in which the rear housing 60 has a suction chamber 61 formed in a front section thereof, a discharge chamber 62 formed in a rear section thereof separated from the front section by a partition 63 and a refrigerant discharge port 64 communicating with the discharge chamber 62 for allowing refrigerant to be discharged to the outside, and the cylinder block 40 has front and rear cylinder blocks 41 and 42 with a plurality of axial bores 41a and 42a at both sides of a swash plate chamber 43 therein and a refrigerant suction port 44 for allowing refrigerant to be introduced from the outside.

In the swash plate chamber 43 inside the cylinder block 40, a swash plate 50 is coupled with the drive shaft 14 at a predetermined inclined angle to rotate along with the drive shaft 14, and a plurality of double head pistons 51 are mounted on the outer periphery of the swash plate 50 with shoes 52 interposed therebetween to compress refrigerant while performing linear reciprocation within the bores 41a and 42a in cooperation with the swash plate 50.

The front and rear housings 30 and 60 are adapted to close both ends of the cylinder block 40 and provided with valve units 70 and 70a between the

housings 30 and 60, respectively, each of which includes a suction valve 71 or 71a and a discharge value 72 or 72a for regulating the flow of refrigerant through the suction chamber 61 and the discharge chambers 31 and 62 of the front and rear housings 30 and 60 and the bores 41a and 42a of the cylinder block 40 in cooperation with suction and compression strokes of the double head pistons 51.

A hub 50a formed integrally with the swash plate 50 is supported at both ends by a thrust bearing 53 within the swash plate chamber 43.

The motor unit 10 and the compressor unit 20 of the motor driven compressor 1 of the afore-described constitution are fixedly coupled with each other via fastening means such as a plurality of bolts as not shown.

The motor driven compressor as above has feeding means 45 for feeding refrigerant, which is introduced into the swash plate chamber 43, partially into the motor room 12 and partially into the suction chamber 61 of the rear housing 60.

The feeding means 45 include first low pressure passages 41b and 34 communicating between the swash plate chamber 43 and the motor room 12 and a second low pressure passage 42b communicating between the swash plate chamber 43 and the suction chamber 61 of the rear housing 60.

The first low pressure passages 41b and 34 are formed through the front cylinder block 41 and the front housing 30, and the second low pressure passage 42b is formed through the rear cylinder block 42.

Therefore, after being sucked in from the outside through the refrigerant suction port 44 and introduced into the swash plate chamber 43, refrigerant is fed partially into the motor room 12 via the first low pressure passages 41b and 34 and partially into the suction chamber 61 of the rear housing 60 via the second low pressure passage 42b.

The front housing 30 has a plurality of suction passages 32 for communicating the motor room 12 to the bores 41a in a communicating fashion so that refrigerant can be fed from the motor room 12 into the bores 41a of the front

cylinder block 41 at the suction stroke of the double head pistons 51.

The front housing 30 may be additionally provided with a suction chamber (not shown) partitioned from the discharge chamber 31. Alternatively, refrigerant may be sucked into the bores 41a directly through the suction passages 32 without the suction chamber.

Also, the discharge chamber 31 of the front housing 30 communicates with the discharge chamber 62 of the rear housing 60 via a communication passageway 48.

Alternatively, a muffler room may be provided in a region communicating the discharge chamber 62 to the refrigerant discharge port 64 of the rear housing 60 in order to lower discharge pressure pulsation.

The motor driven compressor 1 of the above constitution will be described in conjunction with the operation thereof as follows.

Refrigerant fed from the outside is introduced into the swash plate chamber 43 through the refrigerant suction port 44 of the cylinder block 40. Refrigerant contains oil to lubricate sliding components including the swash plate 50, the shoes 52 and the pistons 51 when fed thereto.

In succession, refrigerant is fed from the swash plate chamber 43 partially into the motor room 12 through the first low pressure passages 41b and 34 which communicate the swash plate chamber 43 to the motor room 12, and partially into the suction chamber 61 of the rear housing 60 via the second low pressure passage 42b which communicates the swash plate chamber 43 to the suction chamber 61 of the rear housing 60.

When fed into the motor room 12, refrigerant serves to cool the heat generated from the electric motor 13 to prevent magnetic flux drop originated from the overheating of refrigerant so that the electric motor 13 can maintain performance.

Then, refrigerant is sucked from the motor room 12 into the bores 41a

through the suction passages 32 simultaneously with the opening of the suction valve 72 of the valve unit 70 at the suction stroke of the double head pistons 51.

After being compressed into a high temperature and pressure state in response to the compression stroke of the pistons 51, refrigerant is discharged through the discharge valve 72 of the value unit 70 into the discharge chamber 31 of the front housing 30, and fed into the discharge chamber 62 of the rear housing 60 along the communication passageway 48.

Then, refrigerant is sucked from the suction chamber 61 of the rear housing 60 into the bores 42a of the rear cylinder block 42 through the suction valve 71 of the value unit 70 to be compressed in cooperation with the suction/compression strokes of the pistons 51 as described above so that refrigerant in a high temperature and pressure state is discharged into the discharge chamber 62 of the rear housing 60 via the discharge valve 72 of the valve unit 70.

Then, refrigerant is discharged from the discharge chamber 62 of the rear housing 60 to the outside through the refrigerant discharge port 64 together with refrigerant fed through the communication passageway 48 from the discharge chamber 31 of the front housing 30.

As a consequence, after being introduced into the swash plate chamber 43, refrigerant is fed partially into the motor room 12 to cool the motor unit 10 and partially into the suction chamber 61 of the rear housing 60 to effectively lubricate the sliding components within the swash plate chamber 43 to improve the durability thereof. Also, since the motor unit 10 is cooled by using only partial refrigerant of a low temperature and pressure, this can prevent compression efficiency degradation while enhancing cooling effect.

In addition, unlike a single head swash plate type motor driven compressor of the prior art, the double head swash plate type motor driven compressor 1 of the invention executes compression at both front and rear ends to achieve pressure

pulsation reduction. The motor drive compressor can improve cooling performance based upon high speed rotation even with small discharging capacity, and thus is advantageous when packaged longitudinally with the same capacity.

Further, the double head swash plate type motor driven compressor can decrease the swash plate angle smaller than that of the single head swash plate type motor driven compressor to decrease load at high speed rotation thereby achieving advantageous effect in view of durability.

FIG. 5 is a sectional view illustrating a motor driven compressor according to a second embodiment of the invention, FIG. 6 is a sectional view taken along a line C-C in FIG. 5, FIG. 7 is a sectional view taken along a line D-D in FIG. 5, and FIG. 8 is a sectional view illustrating the motor drive compressor according to the second embodiment of the invention with an inlet passage modified in position, in which only the components and operation different from those of the first embodiments will be described to avoid repeated description of the same parts.

As shown in FIGS. 5 to 8, the second embodiment has feeding means modified from that of the first embodiment, in which the feeding means 17 of the second embodiment include a passage 14a formed longitudinally in a drive shaft 14 for communicating a motor room 12 to a rear housing 60 and inlet passages 15 and 15a for communicating a swash plate chamber 43 to the channel 41a so that refrigerant can be introduced from the swash plate chamber 43 into the passage 14a.

That is, the second embodiment omits the first and second low pressure passages 34, 41b and 42b as the feeding means 45 of the first embodiment, but forms the inlet passages 15 and 15a and the passage 14a in the drive shaft 14 so that refrigerant is fed from the swash plate chamber 43 partially into the motor room 12 and partially into a suction chamber 61 of the rear housing 60.

The inlet passages 15 and 15a may be formed through the drive shaft 14

and a hub shaft of a swash plate, or in a region of the drive shaft 14 placing a thrust bearing 53 rather than a surface thereof with coupling a swash plate 50.

Therefore, refrigerant fed from the outside is introduced into the swash plate chamber 43 through a refrigerant suction port 44 of a cylinder block 40. Refrigerant contains oil to lubricate sliding components including the swash plate 50, shoes 52 and pistons 51 when introduced.

In succession, refrigerant is introduced into the passage 14a of the drive shaft 14 via the inlet passages 15 and 15a.

After being introduced into the passage 14a, refrigerant is halved to feed the motor room 12 and the suction chamber 61 of the rear housing 60.

Other parts are the same as those of the afore-described first embodiment, and thus will not be described.

In the meantime, refrigerant fed into the suction chamber 61 of the rear housing 60 along the passage 14a of the drive shaft 14 lubricates a bearing 16b which rotatably supports an end of the drive shaft 14.

FIG. 9 is a sectional view illustrating a motor driven compressor according to a third embodiment of the invention, FIG. 10 is a sectional view taken along a line E-E in FIG. 9, and FIG. 11 is a sectional view taken along a line F-F in FIG. 9, in which only the components and operation different from those of the first embodiments will be described to avoid repeated description of the same parts.

As shown in FIGS. 9 to 11, the third embodiment further provides a suction muffler chamber 180 which is formed in an upstream section where refrigerant is introduced into a swash plate chamber 143 and has motor-controlling means 181 mounted therein so as to additionally cool the motor-controlling means 181.

The motor-controlling means 181 is preferably constituted of an inverter 182.

Hereinafter a compressor unit 12 will be described only without explanation to a motor unit 10 the same as that of the first embodiment.

The compressor unit 120 is coupled with the motor unit 10 and includes a front housing 130, a rear housing 160 and a cylinder block 140 coupled between the front and rear housings 130 and 160. The front housing 130 has discharge chamber 131 and a suction chamber 135 formed in inside and outside sections, respectively, divided by a partition 133. The rear housing 160 has a discharge chamber 162 and a suction chamber 161 formed in inside and outside sections, respectively, divided by a partition 163 and a refrigerant discharge port 164 for communicating with the discharge chamber 162 for allowing compressed refrigerant to be discharged to the outside. The cylinder block 140 has front and rear cylinder blocks 141 and 142 with a plurality of axial bores 141 and 142a formed at both sides of the swash plate chamber 143 therein and refrigerant suction ports 144 for allowing refrigerant to be introduced from the outside.

Likewise to the first embodiment, the third embodiment may further have a suction chamber formed inside the partitions 133 and 163 and a discharge chamber outside the same, in which the refrigerant discharge port 164 may be formed in the front housing 130.

Also, the discharge chamber 131 of the front housing 130 and the discharge chamber 162 of the rear housing 160 are communicated with each other via a communication passageway 148 formed in the cylinder block 140.

In the swash plate chamber 143 inside the cylinder block 140, a swash plate 150 is coupled with a drive shaft 14 at a predetermined inclined angle to rotate along with the drive shaft 14, and a plurality of double head pistons 151 are mounted on the outer periphery of the swash plate 150 with shoes 152 interposed therebetween to compress refrigerant while performing linear reciprocation within the bores 141a and 142a in cooperation with the swash plate 150.

The front and rear housings 130 and 160 are adapted to close both ends of

the cylinder block 140 and provided with valve units 170 between the front and rear housings 130 and 160, respectively, each of which includes a suction value and a discharge value 72 for regulating the flow of refrigerant through the suction chambers 135 and 161 and the discharge chambers 131 and 162 of the front and rear housings 130 and 160 and the bores 141a and 142a of the cylinder block 140 in cooperation with suction and compression strokes of the double head pistons 151.

A hub 150a formed integrally with the swash plate 150 is supported at both ends by a thrust bearing 153 within the swash plate chamber 143.

Also, the suction muffler chamber 180 is further provided in the cylinder block 140 at an upstream section where refrigerant is introduced into the swash plate chamber 143, and the inverter 182 of the motor-controlling means 181 is installed within the suction muffler chamber 180.

The suction muffler chamber 180 is preferably provided with an inner space to serve as a suction muffler thereby reducing noise and lowering pressure pulsation when refrigerant is fed from the outside.

Further, the refrigerant suction ports 144 formed in the cylinder block 140 are separated into top and bottom sections via the suction muffler chamber 180.

Alternatively, the suction muffler chamber 180 may be not formed integrally with the cylinder block 140, but fabricated separately from the cylinder block 140 and then coupled with the same.

In addition, there is provided feeding means 145 for partially feeding refrigerant which is introduced into the swash plate chamber 143 to cool an electric motor 13 installed in a motor room 10 into the motor room 12 and into the suction chamber 161 of the rear housing 160.

The feeding means 145 include first low pressure passages 141b and 134 formed through the front cylinder block 141 and the front housing 130 to communicate the swash plate chamber 143 to the motor room 12 and a second low

pressure passage 142b formed through the rear cylinder block 142 to communicate the swash plate chamber 143 to the suction chamber 161 of the rear housing 160.

The front housing 130 is provided with a plurality of suction passages 132 for communicating the motor room 12 to the suction chamber 135 so that refrigerant fed into the motor room 12 can be sucked into the suction chamber 135 of the front housing 130.

As a consequence, refrigerant fed from the outside is introduced into the suction muffler chamber 180 via the refrigerant suction port 144 of the suction muffler chamber 180. Introduced refrigerant cools the inverter 182 while serving as the suction muffler, and then is fed into the swash plate chamber 143. In this case, refrigerant cools the swash plate chamber 143 while oil contained in refrigerant lubricates sliding components including the swash plate 150, shoes 152 and the pistons 151.

After being introduced into the swash plate chamber 143, refrigerant is successively fed partially into the motor room 12 through the first low pressure passages 134 and 141b communicating the swash plate chamber 143 to the motor room 12 and partially into the suction chamber 161 of the rear housing 160 through the second low pressure passage 142b communicating the swash plate chamber 143 to the suction chamber 161 of the rear housing 160.

Other parts of the third embodiment are the same as those of the first embodiment described above, and thus will not described further.

Industrial Applicability

As set forth above, the motor driven compressor of the invention first introduces refrigerant into the swash plate and then feeds refrigerant into the motor room and the suction chamber of the rear housing, so that the sliding components within the swash plate chamber are efficiently lubricated, in order to improve durability as well as the cooling efficiency of the motor unit, thereby

preventing the performance degradation of the electric motor and improving the overall performance of the motor driven compressor.

Further, the motor driven compressor of the invention cools the motor unit by only using partial low temperature and pressure refrigerant and compresses refrigerant at front and rear sections to relatively prevent degradation in compression performance while enhancing cooling effect.

External refrigerant is sucked into the suction muffler room before being fed into the swash plate chamber so that inverter is cooled by suction refrigerant to restrain the inverter from heating and the inner space of the suction muffler chamber also serves as a suction muffler for preventing noise and reducing pressure pulsation when refrigerant is sucked in.

Unlike the prior single head swash plate type motor driven compressor, due to the compression at front and rear sections, the present compressor can have an excellent pressure pulsation reduction, the size of the compressor can be reduced as well as keeping its capacity and the swash plate angle can be lessen that results in less load at high-speed rotation. Therefore, the present compressor is advantageous in view of durability.